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May 20, 2004

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

Subject: Duke Energy Corporation (Duke)
McGuire Nuclear Station Units 1 and 2
Docket Numbers 50-369 and 50-370
Technical Specifications Amendment
Request for Additional Information (RAI); TS 3.7.15 - Spent Fuel Assembly Storage, and TS 4.3 - Fuel Storage

Reference: (1) Duke letter to NRC, dated September 29, 2003, (2) Duke Letter to NRC, dated April 22, 2004, and (3) NRC letter to Duke, dated March 8, 2004 (TAC NOS. MC0945 AND MC0946)

This letter provides additional information that was requested by the NRC staff in the above referenced NRC letter and further clarified during several teleconference calls. It was agreed between the NRC staff and Duke during an April 15, 2004 teleconference call that Duke's responses to Questions No. 11 and 19 would be provided prior to May 21, 2004. Duke's responses are provided in the following attachment.

Please contact Norman T. Simms of Regulatory Compliance at 704-875-4685 with any questions with respect to this matter.

Very truly yours,

G. R. Peterson

Attachment

A001

xc: (w/attachment)

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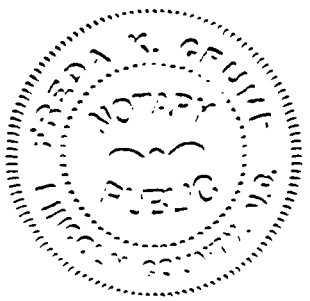
Gary R. Peterson, being duly sworn, states that he is Vice President of McGuire Nuclear Station; that he is authorized on the part of Duke Energy Corporation to sign and file with the U.S. Nuclear Regulatory Commission these revisions to the McGuire Nuclear Station Facility Operating Licenses Nos. NPF-9 and NPF-17; and, that all statements and matters set forth therein are true and correct to the best of his knowledge.

Gary R. Peterson, Vice President
McGuire Nuclear Station
Duke Energy Corporation

Subscribed and sworn to before me on May 20, 2004.

Notary Public

My Commission Expires: August 17, 2006



ATTACHMENT

Responses to Nuclear Regulatory Commission Request for Additional Information Related to McGuire Nuclear Stations's License Amendment Request for No-Boraflex Credit

Question 11

In Section 8.2, "SFP Region 2 Criticality Analysis," of Attachment 6, the licensee described how it homogenized the Region 2 rack model for analysis using CASMO-3. To accomplish this, the licensee stated that the cell wall location was adjusted in the model to be located at the midpoint between the stored assemblies; thereby, making neighboring cells identical to each other. This change affects the amount of moderator directly adjacent to each assembly. Please describe in greater detail how the dimensions of the model differ from those of the actual racks. In Table 8, the licensee provided a limited set of comparison calculations which show significant variability between KENO V.a heterogeneous and homogenous models and a CASMO-3 homogenous model. The most bounding rack analysis varies based on model used, fuel type, and enrichment. This table fails to demonstrate that the licensee's CASMO-3 homogenous model conservatively bounds either the KENO V.a homogenous or heterogeneous models for varying fuel types and enrichments. Therefore, please evaluate the reactivity difference between an actual rack loaded with fuel of the highest permissible reactivity and the homogenous model rack loaded with fuel of the highest permissible reactivity. Also, please provide sufficient information to demonstrate that the model conservatively bounds the actual rack design for all fuel types and enrichments.

Response

The heterogeneous (actual) Region 2 storage rack model is shown in Figure 11.1. Note that for most of the radial length of the Boraflex wrapper plate there is a gap between the plate and the storage cell wall. Because no credit was taken for any remaining Boraflex material that would be present in these gap areas, water was modeled there for the SFP criticality analysis.

To allow CASMO-3 and SIMULATE-3 to model the Region 2 storage rack, the thicknesses of the wrapper plate and the storage cell wall were combined, the water gap was eliminated, and the combined stainless steel cell structure was centered between the fuel assembly storage locations – see Figure 11.2.

To assess the validity of "homogenizing" the Region 2 rack in this manner, 2-D fresh fuel SCALE 4.4 / KENO V.a cases were run for both the heterogeneous and homogeneous rack model. These cases considered three different fresh fuel enrichments (1.08, 3.00, and 5.00 wt % U-235) for three different fuel assembly designs (W-RFA, W-OFA, and MkBI). The 1.08 wt % U-235 enrichment was chosen because it yielded the highest permissible reactivity – maximum 95/95 $k_{eff} < 1.0$ in unborated water – for Unrestricted fresh fuel storage of the most reactive fuel type in McGuire Region 2. Note that the W-STD and MkBW fuel designs were not included in these evaluations because, for a 2-D slice, the W-RFA design is neutronically similar to these fuel types.

The limited KENO V.a results shown in Table 8 of Attachment 6 exhibited moderate variability due to the uncertainty in the calculated k_{eff}s ($\sigma \approx 0.0009$ Δk). To reduce the Monte Carlo variations for the KENO V.a cases performed here, forty (40) different random number seed cases were performed for each rack model / enrichment / fuel design combination, and the resulting 40 k_{eff} results were averaged together. This decreased the overall average k_{eff} uncertainty considerably ($\sigma \approx 0.00015$ Δk).

For comparison to these heterogeneous and homogeneous KENO V.a calculations, CASMO-3 cases were carried out with the Figure 11.2 homogeneous Region 2 rack model. The base k_{eff} results from all the computations are presented in Table 11.1. Calculations for all cases were performed at both 32 and 150 °F. The higher of the computed k_{eff}s at these SFP temperature bounds is shown in the Table 11.1 data. Note that SCALE 4.4 / KENO V.a gives nearly the same average k_{eff}s (within 0.0004 Δk) for the heterogeneous and homogeneous Region 2 rack models, for all enrichments and fuel designs. In general, the KENO V.a homogeneous model is slightly conservative (by an average 0.0002 Δk for the nine enrichment / fuel type combinations in Table 11.1), as desired. No trends were observed, with respect to fresh fuel enrichment, fuel type, or temperature, in the KENO V.a homogeneous-to-heterogeneous model comparisons.

The CASMO-3 base k_{eff} comparisons with KENO V.a in Table 11.1 do show a trend with respect to fresh fuel enrichment. The average CASMO-3 to KENO V.a base k_{eff} bias decreases with increasing fuel enrichment, ranging from about +0.003 Δk at 1.08 wt % U-235 to about -0.001 Δk at 5.00 wt % U-235. One would expect the base CASMO-3 k_{eff} to be higher than the KENO V.a k_{eff} for a particular case, because of differences in critical experiment benchmark method biases and uncertainties between these two codes – see Section 6 in Attachment 6 of the LAR. It is important to note, however, that the fresh 3.00 and 5.00 wt % U-235 cases yield k_{eff}s that are much higher than those associated with the benchmark critical experiments, or in actual SFP fuel storage conditions. Thus, comparisons between CASMO-3 and SCALE 4.4 / KENO V.a results really aren't useful for the 3.00 and 5.00 wt % U-235 cases in Table 11.1, because these reactivity conditions ($k_{eff} > 1.3$) are very different from those of the benchmark fresh fuel critical experiments ($k_{eff} \approx 1.0$). Fuel at these enrichments needs significant burnup to allow storage in the McGuire Region 2 racks (as shown in Tables 18 through 21 in Attachment 6 of the LAR), enough that the remaining U-235 content is below 2 wt %, even for Checkerboard storage with 20 years of cooling time. As far as other irradiated-fuel isotopes are concerned, the response to Question 19 of this RAI assesses the calculated reactivity differences between CASMO-3 / SIMULATE-3 and KENO V.a for high-enriched fuel assemblies meeting the required burnup for Region 2 storage.

Table 11.2 provides a comparison of the CASMO-3 and KENO V.a results for the 1.08 wt % U-235 cases from Table 11.1, on a total 95/95 k_{eff} basis. The pertinent bias and uncertainty contributors listed in this table were documented in Section 6 of Attachment 6 to the LAR. Table 11.2 demonstrates that on a 95/95 basis, for fresh fuel of the maximum permissible reactivity, the CASMO-3 homogeneous Region 2 rack model is slightly conservative relative to either the homogeneous or heterogeneous KENO V.a model.

Table 11.1. KENO V.a and CASMO-3 Base k_{eff} Results for McGuire SFP Region 2 Storage Rack Models (fresh fuel, max k_{eff} at 32 °F or 150 °F)

	1.08 wt % U-235			3.00 wt % U-235			5.00 wt % U-235		
Fuel Design	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous
MkBI	0.98058	0.97687	0.97647	1.32757	1.32631	1.32636	1.44694	1.44800	1.44779
W-OFA	0.95594	0.95305	0.95282	1.31605	1.31510	1.31467	1.44248	1.44324	1.44292
W-RFA	0.97158	0.96854	0.96841	1.31893	1.31841	1.31857	1.43893	1.44067	1.44034

Table 11.2. Total 95/95 k_{eff} KENO V.a and CASMO-3 Comparison for McGuire SFP Region 2 Storage Rack Models (1.08 wt % U-235 fresh fuel, max k_{eff} at 32 °F or 150 °F)

	MkBI Fuel			W-OFA Fuel			W-RFA Fuel		
	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous	CASMO homo-geneous	KENO homo-geneous	KENO hetero-geneous
Nominal k_{eff}	0.98058	0.97687	0.97647	0.95594	0.95305	0.95282	0.97158	0.96854	0.96841
Benchmark Method Bias	0.00000	0.00640	0.00640	0.00000	0.00640	0.00640	0.00000	0.00640	0.00640
Benchmark Method Unc	0.01211	0.00660	0.00660	0.01211	0.00660	0.00660	0.01211	0.00660	0.00660
Monte Carlo Uncert	--	0.00025	0.00025	--	0.00025	0.00025	--	0.00025	0.00025
Mechanical Uncerts	0.01110	0.01110	0.01110	0.01110	0.01110	0.01110	0.01110	0.01110	0.01110
95/95 k_{eff}	0.99701	0.99619	0.99578	0.97237	0.97236	0.97214	0.98801	0.98786	0.98772

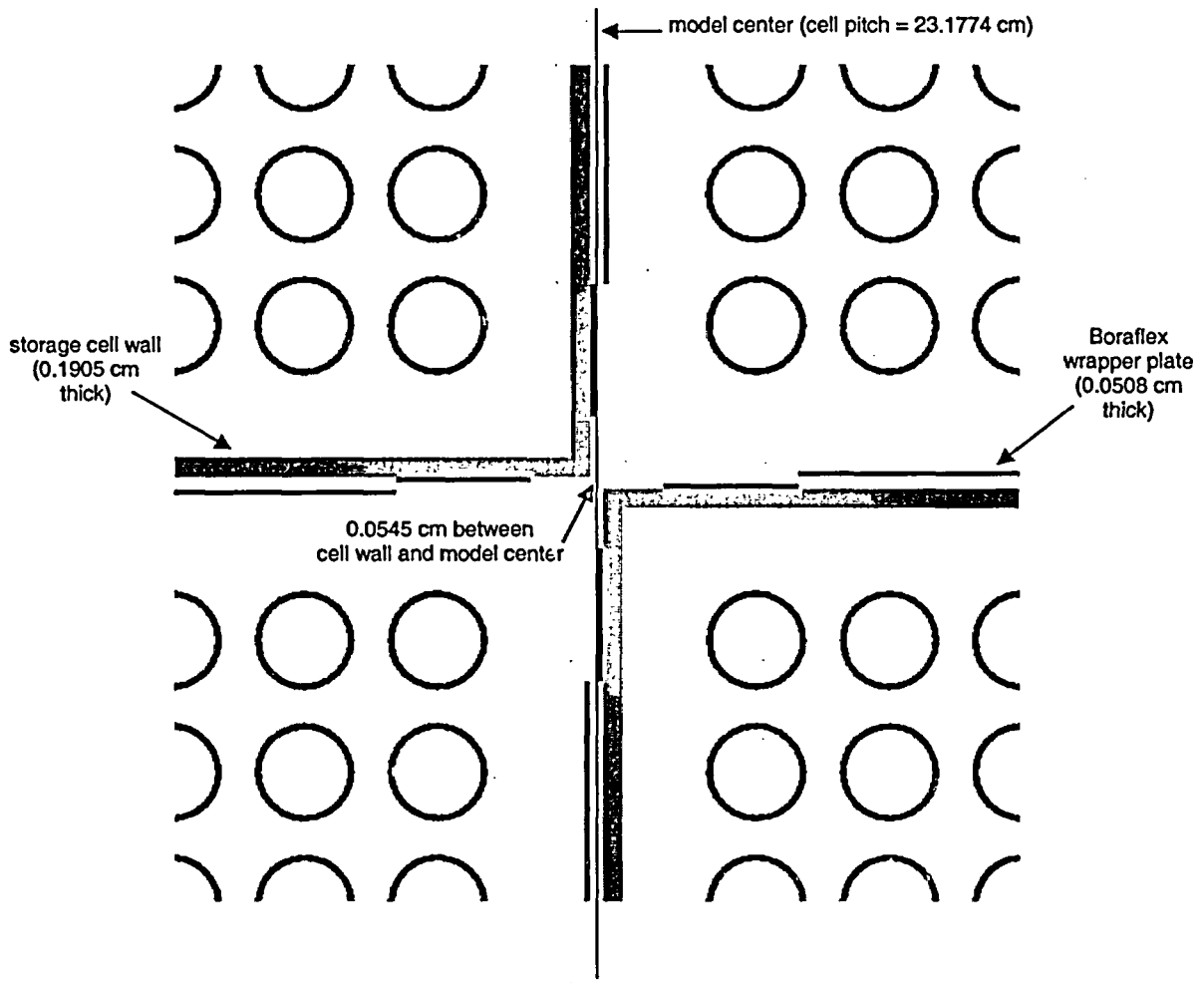


Figure 11.1. McGuire SFP Region 2 Storage Rack – Heterogeneous Model

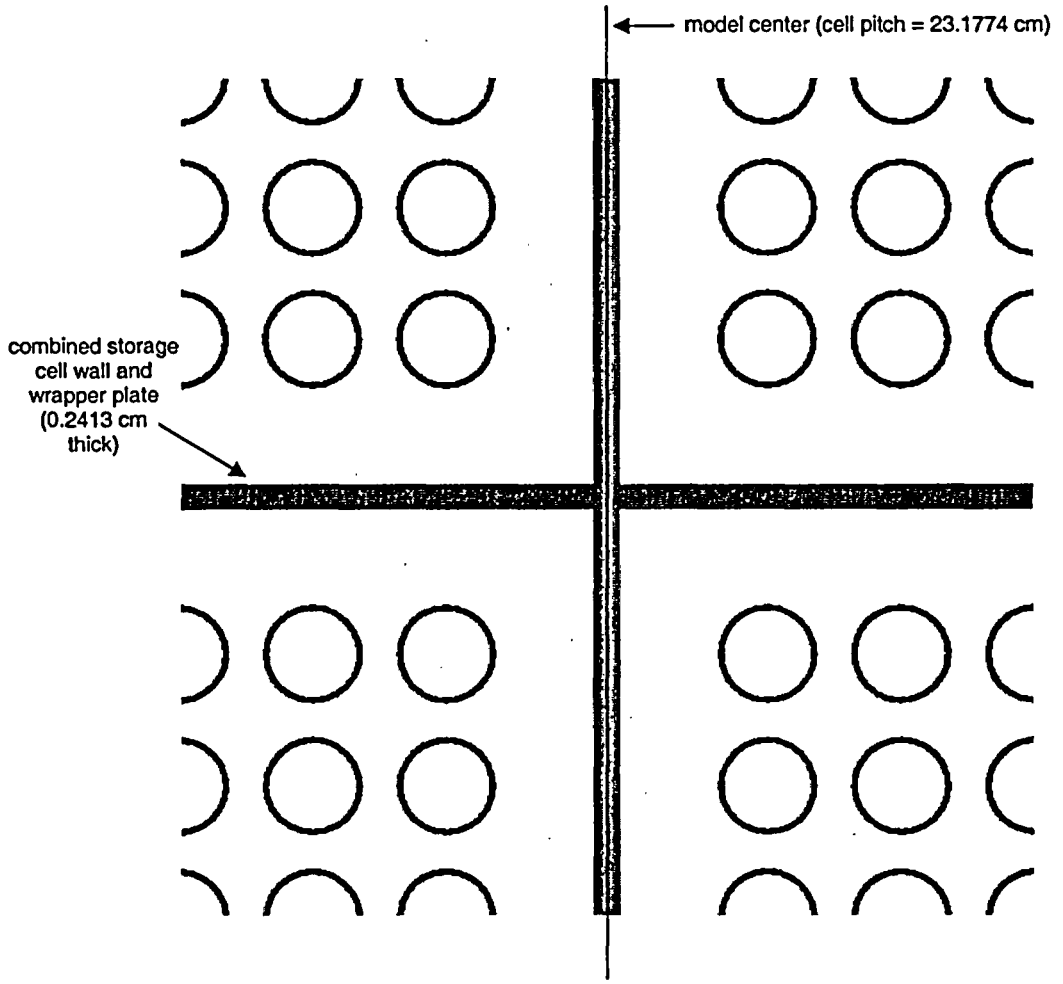


Figure 11.2. McGuire SFP Region 2 Storage Rack – Homogeneous Model

Question 19

In accordance with the guidance provided in the August 19, 1998, Kopp letter, "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants," please verify the results of the primary method of analysis (CASMO-3) for the Region 2 spent fuel racks. The licensee should perform a second, independent analysis of the Region 2 racks loaded with the bounding reactivity configuration presented in Table 22 of its amendment request. Furthermore, the licensee's second analysis should use the KENO V.a code to independently confirm that the bounding storage configuration in Region 2 racks will remain below 1.0 when flooded with unborated water.

Response

A simplification of the configuration presented in Table 22 is used for this analysis. Specifically, the axial variations in the history effects of moderator temperature, fuel temperature, boron concentration and BPRA presence are excluded. This helps to significantly simplify the problem, without affecting the ability to compare the calculated system reactivity with both CASMO/SIMULATE and KENO V.a. The problem must be further simplified, since KENO V.a does not recognize the CASMO Lumped Fission Product Groups 1 and 2, nor the isotopes of Np-239 and Pu-239. Therefore, a common group of isotopic concentrations must be developed for use in both CASMO and KENO. This is accomplished by setting equal to zero the isotopic concentrations of the LFP Groups 1 and 2, Np-239 and Pu-239 and adding a concentration of Xe-135 in CASMO until the k_{eff} is equal to the original CASMO k_{eff}. Then this set of isotopic concentrations is used for both the CASMO and KENO calculations in the comparison of k_{eff} for the two codes.

The results, corrected for method bias and uncertainty, show that KENO V.a calculates a k_{eff} of 0.98775 and CASMO/SIMULATE calculates a k_{eff} of 0.99070 – see Table 19.1. The difference is 0.00295 Δk. This shows that there is good agreement between the two codes for handling burned fuel isotopics. The difference can most reasonably be explained due to the different cross-section libraries. SCALE 4.4 / KENO V.a uses a 238 group ENDF/B-V cross-section library and CASMO-3 uses a 70 group ENDF/B-IV cross-section library. Although the burnup-related biases and uncertainties have been calculated for CASMO, the equivalent biases and uncertainties remain undetermined for KENO V.a. Since calculations of the burnup related biases and uncertainties for KENO V.a are not practical using the methods employed for CASMO, a comparison of the 95/95 calculated k_{eff} is not possible. However, it is sufficient to show that the two methodologies have a general agreement.

Table 19.1 Comparison of Calculated k_{eff} from SIMULATE and KENO

	SIMULATE	KENO
Nominal k_{eff}	0.97859	0.97460
Biases		
Benchmark Method Bias	--	0.0064
Uncertainties		
Benchmark Method Uncertainty	0.01211	0.0066
Monte Carlo Computational Uncertainty	--	0.00141
Calculated k_{eff} (including Method Bias and Uncertainty)	0.99070	0.98775